

## Review

# Use of information-seeking strategies for developing systematic reviews and engaging in evidence-based practice: the application of traditional and comprehensive Pearl Growing. A review

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### Abstract

*Background:* Efficient library searches for research evidence are critical to practitioners who wish to engage in evidence-based practice (EBP) as well as researchers who seek to develop systematic reviews.

*Aims:* This review will propose the benefits of the search technique 'Pearl Growing' ('Traditional Pearl Growing') as well as an adaptation of this technique ('Comprehensive Pearl Growing'), until now ignored by the literature on EBP and systematic reviews, to aid in the retrieval of research evidence. These search techniques are illustrated with examples from the field of augmentative and alternative communication.

*Main Contributions:* Traditional Pearl Growing is proposed as an important addition to the arsenal of EBP search strategies for practitioners. The literature on Traditional Pearl Growing is extended in that EBP presents a newly identified purpose for this technique and the benefits in identifying appropriate quality filter goes beyond its previously exclusive focus on keywords. Comprehensive Pearl Growing is projected as a new strategy for researchers searching for studies to be included in systematic reviews. Not only does it

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provide data-based guidance in selecting effective keywords and quality filters, but also it provides appropriate databases.

*Conclusions:* Although the techniques Traditional Pearl Growing and Comprehensive Pearl Growing are believed to be useful for locating research evidence in any field, it may be particularly important for interdisciplinary topics where the use of effective controlled vocabulary plays a greater role in bringing together evidence that may be scattered across databases.

*Keywords:* augmentative and alternative communication, evidence-based practice, literature searching, systematic reviews.

## Introduction

Evidence-based practice (EBP) is increasingly being recognized as the preferred approach to practice in communication disorders in general (Reilly *et al.* 2003) and augmentative and alternative communication (AAC) in particular (Schlosser 2003, Schlosser and Raghavendra 2004). From an international perspective, many professional organizations in North America and the UK have started to promote EBP as a major paradigm of service delivery. In 2004, members of the American Speech–Language–Hearing Association (ASHA) formed a Joint Coordinating Committee on EBP. Their technical report describes the major goal of EBP in audiology and speech–language pathology as ‘improving sense-of-wellness and functional health among the clinical populations’ (ASHA 2004: 2). ASHA’s 2005 position statement recommends that audiologists and speech–language pathologists implement EBP principles in clinical decision making to ensure high quality clinical care. Transforming clinical practice into EBP requires shifting away from decision-making based on expert opinion and moving towards the integration of clinical expertise, the best current research evidence, and individual client values (ASHA 2005).

In Great Britain, the Royal College of Speech and Language Therapists (RCSLT) has incorporated EBP in its mission statement and model of professional practice. The RCSLT’s vision for the development of the profession emphasizes EBP to be embedded in therapeutic care at all levels (RCSLT 2003). Practitioners are charged with the responsibility to provide ‘evidence-based, clinically competent care’, and clinical activity should be based on recent and ‘most appropriate’ knowledge (Williamson 2001: 16). In a broader health care context, the National Institute for Health and Clinical Excellence (NICE) of the UK supports the implementation of EBP by developing clinical guidelines that are based on best available evidence regarding appropriate treatments for specific clinical populations. NICE’s aim is to improve the quality of health care to the maximum extent possible (NICE 2005). In an effort to facilitate the retrieval of research evidence an international non-profit organization was established, called the Cochrane Collaboration. Its major goal is to disseminate up-to-date, accurate information about the effects of healthcare. The Cochrane Collaboration supports the search for evidence by producing and publishing systematic reviews of healthcare interventions (Cochrane Collaboration 2005). These reviews are made available world wide through the Cochrane Database of Systematic Reviews, which has become a major resource for the EBP practitioner. The Database of Abstracts of Effects (DARE), housed by the Centre for Reviews

and Dissemination at the University of York, goes one step further in that it offers appraisals of reviews (<http://www.york.ac.uk/inst/crd/darehp.htm>).

EBP as a process involves several steps, including the construction of a well-built question, the searching for research evidence, the appraisal and synthesis of the evidence, the application of the evidence, an evaluation of the application, and the dissemination of the findings (Sackett *et al.* 1997, Schlosser and Raghavendra 2004). Although each of these steps is necessary for successful EBP implementation, this paper focuses on the critical role of searching for research evidence in AAC. Searching is especially important because of the interdisciplinary nature of AAC, with evidence pertaining to AAC being scattered across a vast array of sources in a variety of related fields (Schlosser 2003). Second, as Schlosser *et al.* (2005) pointed out, the consequences of an inadequate search could be rather devastating in that a practitioner may conclude that an intervention is more or less effective than it really is or misjudge the applicability of the evidence to the particular client.

Two purposes of searching for evidence: engaging in EBP and producing systematic reviews.

Schlosser *et al.* (2005) described the assumptions and underpinnings for the search of evidence in support of EBP and contrasted it with the search for studies typically conducted for a systematic review. First, practitioners seeking evidence for EBP are pressed for time whereas researchers conducting a systematic review typically have more time at their disposal. Second, EBP searches can draw from literature retrieval strategies developed for systematic reviews in many ways (including the use of multifaceted search strategies, delineated limitations of individual search methods, and knowledge of how databases are structured) while being mindful of crucial differences in the respective aims of the searches. These differences and similarities are depicted in table 1. To summarize the differences, EBP searches are characterized by their need for (1) time-efficiency, (2) identifying the best and most current evidence first, and (3) identifying evidence that is pre-filtered. This may be accomplished by using so-called quality filters or hedges (e.g. only randomized controlled trials), as well as temporal boundaries (e.g. only evidence published after 1990).

The preferred approach is to minimize the need for practitioners to apply quality filters themselves by first consulting those sources and specialized databases that offer pre-filtered evidence. Melnyk and Fineout-Overholt (2002) defined pre-filtered

**Table 1. Characteristics of searches for two purposes**

<u>Characteristics</u>	Searches to identify studies for developing systematic reviews	Evidence-based practice (EBP) searches
<u>Type of search</u>	Exhaustive search: retrieve all evidence and avoid missing studies outside of regular purview	Best evidence search: identify the best and most current evidence first
<u>Effort/efficiency</u>	Efficiency is helpful but not a priority: 'leave no stone unturned'	Time efficiency is a must because clinicians' time is limited
<u>Use of quality filters</u>	Quality filters are typically not used	Use of quality filters to identify evidence that represents a certain quality of is pre-filtered or represents the highest quality available

evidence as follows: ‘an individual or group of individuals with expertise in a particular substantive area has reviewed and presented the methodologically strongest data in the field’ (p.263). Such sources allow practitioners to rely on the appraisal of evidence already implemented by others rather than having to apply quality filters themselves. If such pre-filtered sources are not available or do not yield sufficient information, however, practitioners have to apply quality filters themselves. Quality filters are limiters that one can use in database searches to filter out evidence of lower quality based on the EBP hierarchy of evidence suggested for the field of communication disorders (Gallagher *et al.* 2002). One way to limit a search is by specifying the desired research design. This aims to provide the best evidence according to the evidence hierarchy most appropriate for the type of information sought (Gallagher *et al.* 2002). Similarly, it is more efficient to locate systematic reviews before seeking out individual studies. Systematic reviews, in particular, offer a type of pre-filtered evidence and therefore allow practitioners to minimize effort to locate individual studies and then to have to appraise and synthesize them thereafter. Systematic reviews have gained increasing prominence as a preferred source of pre-filtered evidence among practitioners seeking to engage in EBP (Davies and Crombie 1998).

More time-consuming strategies such as hand searches or ancestry searches tend to be less applicable. Hand searches require the scanning of tables of contents along with the scanning of the annual index of the journals. Ancestry searches involve the use of reference lists of identified studies to locate additional studies. These latter techniques alongside many others are recommended when searching for evidence in order to implement a systematic review. In fact, White (1994) lists a total of 15 strategies that may be utilized for retrieving evidence in an exhaustive manner.

### General space of search strategies

The fields of library science and information science have long been working on describing and maximizing search strategies. For instance, Markey and Atherton (1978) and Hawkins and Wagers (1982) recommended five search strategies to intermediary searchers, including (1) Building Block, (2) Most Specific Facet First, (3) Successive Fractions (or Big Bite), and (4) Citation Pearl Growing.

The *Building Block* strategy asks the searcher to break up an information need (e.g. do speech generating devices make a difference for communication partners?) into facets (e.g. speech generating device, effects, listeners) and to construct a query by generating terms within each facet and connecting them with an OR operator (e.g. speech generating device OR voice output communication aid OR communication aids for the disabled). Subsequently, all facets are strung together with AND operators (e.g. voice output communication aid or communication aid for the disabled AND listeners or communication partners AND effects or effectiveness).

The strategy *The Most Specific Facet First* begins with a topic analysis in which a topic is broken down into facets; the facet most specific to the problem is applied first in the search. Facets that are unnecessary or may be implied in other facets are ignored. For instance, the topic ‘strategies for transitioning from prelinguistic to linguistic communication in children with developmental disabilities’ can be broken down into the following facets: (1) prelinguistic, (2) linguistic, (3) transition, (4)

communication, (5) developmental disabilities, (6) children, and (7) strategies. The facets ‘transition’ and ‘strategies’ are probably too fuzzy and should be eliminated. The term ‘linguistic’ would probably retrieve studies with participants who are already at a linguistic level and therefore is also ignored. For the remaining facets, the searcher would identify controlled language vocabulary for each of them before embarking on an initial search.

The *Successive Fractions* strategy is useful for someone who is unfamiliar with a topic. For example, someone may want to explore the effectiveness of AAC interventions. With this strategy, the searcher would start with an initial search of the broad topic by entering ‘alternative and augmentative communication’ into the Cumulative Index of Nursing and Allied Health Literatures (CINAHL) — this yields 392 entries (13 July 2005). With these many entries the searcher will then have to apply a series of useful restrictions to combine with the above term using AND operators. More often than not, searchers using this strategy will gain these restrictions from scanning a few entries from the broad search. For example, the searcher may locate a suitable key word (Major Heading [MH]) for ‘intervention’ and restrict the target population to individuals with developmental disabilities. The search string (MH ‘Alternative and Augmentative Communication’) and [(MH ‘Research, Speech–Language–Hearing Therapy’) or (MH ‘Communication Skills Training’)] and (MH ‘Developmental Disabilities’) yields ten entries — much more manageable.

These fundamental strategies, in particular Pearl Growing (which will be the focus of the remainder of the paper), have been ignored by the EBP searching literature. In fact, Pearl Growing has neither explicitly figured into the above assumptions and underpinnings of an EBP search nor into any of the articles on EBP searching reviewed in preparing a recent manuscript on searching for evidence in AAC (Schlosser *et al.* 2005).<sup>1</sup> Because we believe that Pearl Growing and an adaptation thereof offer considerable benefits to practitioners who wish to engage in EBP and researchers seeking evidence for implementing systematic reviews, there is a need to draw attention to this technique. Thus, the purpose of this paper is to describe and illustrate the benefits of the Pearl Growing strategy (‘Traditional Pearl Growing’) and its variant (‘Comprehensive Pearl Growing’) for practitioners seeking evidence to engage in EBP as well as for researchers interested in implementing systematic reviews, respectively. To do so we will first define the Traditional Pearl Growing strategy and illustrate it with an AAC example. Next, we will introduce an adapted Pearl Growing strategy and illustrate how it works with an AAC example. The differences and similarities between Traditional Pearl Growing and Comprehensive Pearl Growing will be discussed; their respective benefits will be proposed.

## **Traditional Pearl Growing**

### *Definition of Traditional Pearl Growing*

Traditional Pearl Growing (TPG) or Citation Pearl Growing involves the following process: (1) find a relevant article; (2) find the terms under which the article is indexed in database-1; (3) find other relevant articles in database-1 by using the index terms in a Building Block query; (4) repeat 2 and 3 in other databases; (5)

repeat steps 1–4 for other relevant articles; and (6) end when articles retrieved provide diminishing relevance.

TPG begins with a specific document or document set that is known to be relevant to the topic at hand (so-called ‘pearl/s’). The searcher reviews the characteristics of that document or documents, adds their key words to the search in order to retrieve additional ones — (‘growing more pearls’) (Hawkins and Wagers 1982). This strategy is iterative in that this additional material may be reviewed as well to further refine the search and to locate even more material, and this is continued until no further material is found. In the more customary terminology of library science, Pearl Growing has been described as one that begins with high precision and then gradually increases recall (Harter 1986). In terms of the timing within an overall search strategy, Drabenstott (2004) notes she often uses this strategy in the middle of a search that originated as a Building Block Strategy, suspends the search to do some Pearl Growing, and then returns to the original search with new and more productive ideas.

TPG does bear some similarities with other techniques. For example, the search begins with an already identified study or review that is relevant to the topic of interest. This reference may have been identified through any of the conventional search strategies. Up to this point, TPG is similar to ancestry searches and forward citation searches because they, too, start with an identified relevant reference. In ancestry searches, the searcher examines the reference list of a relevant article to identify more relevant citations that were published previously. In a forward citation search, the individual takes an identified citation or reference and tracks its after-life to identify which other subsequently published sources have cited this reference (White 1994). Traditional Pearl Growing, however, differs in other important ways. Once the relevant citation is identified, the individual examines the keywords under which the ‘pearl’ was indexed rather than checking who has subsequently cited this reference or what other references might be included in the reference list. Therefore, while there are similarities with ancestry searches and forward citation searches, there are also important differences.

#### *Illustration of Traditional Pearl Growing*

Suppose a clinician is interested in finding evidence concerning the following question: a team of practitioners and family members, serving a 6-year-old child with severe to profound mental retardation, deemed it appropriate to introduce manual signing. They are, however, unsure what instructional strategy is most effective and efficient to yield successful expressive use (signing or speech) and receptive learning.

Our ‘pearl’ in this case is an article by Clarke *et al.* (1988). Because this is a study rather than a review, it is not going to be indexed in any of the specialized databases such as DARE. In other words, the characteristics of this reference are not going to be helpful in retrieving pre-filtered reviews. So, we proceed immediately to general-purpose databases, and start with MEDLINE. Our ‘pearl’ is indexed under the following Medical Subject Heading (MeSH) terms: *Child*; Child, Preschool; *Communication Methods, Total*; *Comparative Study*; Female; Humans; Imitative Behavior; Male; *Manual Communication*; *Mental Retardation/rehabilitation*; Rehabilitation; Research Support, Non-US Government; *Sign Language*; and *Speech*. We have italicized those MeSHs that seem most relevant to identify similar studies and used

them in our search query. Unfortunately, the 'pearl' was not indexed with a particular publication type, which could have informed our subsequent searches in terms of quality filters. Still, among the MeSH terms, 'comparative study' can serve to filter out studies that involve only one treatment.

Our first goal, consistent with the EBP strategy, is to locate reviews. To do so we included relevant terms, excluded irrelevant terms (e.g. 'comparative study' cannot apply to a study and a review at the same time), and formulated the search as follows: [(communication methods, total OR sign language OR manual communication) AND (mental retardation OR developmental disabilities)] using 'child,' 'human' as limiters, and sequentially 'meta-analysis,' 'review,' and 'practice guideline' as quality filters. The search was successful only when using 'review' as a quality filter, resulting in nine entries of which one seemed applicable to the population (Wilken 1996). Then we expanded our search to individual studies using the following query: [(communication methods, total OR sign language OR manual communication) AND comparative study AND (mental retardation OR developmental disabilities) AND speech)] using 'child' and 'human' as limiters. This yielded three additional relevant references (Sisson and Barrett 1984, Kahn 1981, Wells 1981). This also revealed 'speech therapy' and 'language therapy' as two additional potential key words. A repeat of the search with the additional key words yielded no further entries. In terms of quality filters, we noticed inconsistent use of publication types ranging from case report (Sisson and Barrett 1984, Wells 1981) to clinical trial and randomized controlled trial (Kahn 1981). Next, we repeated this search but dropped 'speech' as one of the outcomes of interest because not all relevant studies may have measured speech production or indexed it accordingly. This resulted in no additional relevant references, thus making it unnecessary to conduct more MEDLINE searches.

Because AAC is a literature that is scattered across a variety of fields (Schlosser 2003), we checked PsycINFO as well (through the provider EBSCO), starting with the same 'pearl' (Clarke *et al.* 1988). This 'pearl' is indexed under the following Descriptors (*communication skills training*, phenylketonuria, *sign language*, *severe mental retardation*, and *verbal communication*) and Form/Content Type of 'empirical study' as a quality filter. This provided some valuable keywords (in italics) and one quality filter to start with. First, we supplemented other relevant keywords to describe better the population of developmental disabilities using the thesaurus. Then, we initiated our first search for reviews with the following search string: [(DE 'Sign Language' or DE 'Verbal Communication') and (DE 'Communication Skills Training') and (DE 'Mental Retardation' or DE 'Developmental Disabilities')] using the publication type 'literature review' as a quality filter. This revealed no hits.

Subsequently, we tried for individual studies using the same query with the following limiters: preschool child, and school-age child. This resulted in five hits with four meeting our relevancy criteria (Bonta and Watters 1983, Gaines *et al.* 1988, Light *et al.* 1990, Remington *et al.* 1990). It turns out that all of these hits were indexed under the form/content type of 'empirical study,' just like the 'pearl'. Therefore, if we had applied this quality filter to our search query, like we did in MEDLINE, we would have been successful in that we would have located the same entries. An analysis of keywords revealed no viable additional ones and so we abandoned the search for more entries. Given the aim of illustration, the searches in MEDLINE and PsycINFO shall be sufficient for the reader to get a sense of traditional pearl growing as a technique. If this were done for a clinical question in

real life, however, the searcher would be well advised also to search other databases such as the CINAHL, Educational Resources Information Center (ERIC), and the Language and Linguistics Behavior Abstracts (LLBA).

## **Comprehensive Pearl Growing**

### *Definition of Comprehensive Pearl Growing*

Comprehensive Pearl Growing (CPG) involves the following process: (1) Start with a compilation of studies from a relevant review or a topical bibliography; (2) determine relevant databases for these studies; (3) determine how these studies are indexed in database 1 in terms of keywords and quality filters; (4) find other relevant articles in database 1 (or as many are relevant) using the index terms in a Building Block query; and (5) end when articles retrieved provide diminishing relevance. Thus, rather than beginning with only one pearl, CPG requires of the searcher to begin with a *compilation of studies* from a relevant narrative review or a topical bibliography. Like TPG, CPG makes use of existing studies to determine the keywords and quality filters under which they are indexed in order to retrieve more articles of the same kind.

## **Illustration of Comprehensive Pearl Growing**

Suppose a researcher is interested in pursuing the same question as the one posed for the illustration of TPG, keeping in mind that systematic review questions tend to be focused more on a population rather than a particular individual. Here, CPG begins with a narrative review of comparative intervention studies in AAC for people with developmental disabilities (Schlosser and Sigafoos 2006). Using a variety of search methods, 41 studies were located which qualified for inclusion in their review. We first eliminated those studies that did not focus on the comparison of instructional methods to introduce manual signing and then used CPG to determine in which databases the relevant studies were indexed (table 2).

### *Determining relevant databases*

This was accomplished by conducting an author search in the following databases: CINAHL, ERIC, MEDLINE, LLBA, PsycINFO, and the Web of Science. The results are presented in table 2 with the following yield: CINAHL (0 references), ERIC (4), MEDLINE (7), PsycINFO (15), LLBA (4), and the Web of Science (9). Another way to look at the results in table 2 is to determine how many unique entries are contributed by each of the databases. Unique entries are those that were not retrieved through any of the other databases. Not surprisingly given the complete indexing of all 15 studies, PsycINFO represents the only database that contributed any unique entries — two, to be exact. For the searcher interested in additional more recent or future entries related to this question, the unique entry results and the total yield results from this Comprehensive Pearl Growing search might suggest a very concrete course of action: search only PsycINFO. These results demonstrate that although AAC is indeed a scattered literature (i.e. relevant references are indexed across multiple databases) (Schlosser *et al.* 2005), for some



**Table 2. Indexing of comparative manual signing treatment studies in general-purpose databases**

Reference <sup>a</sup>	CINAHL	ERIC	MEDLINE	PSYC-INFO	LLBA	Web of Science
Barrett (1987)		×	×	×		×
Bennett (1986)		×		×		×
Clarke (1986)		×	×	×		×
Clarke (1988)			×	×		×
Conaghan (1992)				×		
Dalrymple (1992)				×		
Ducker (1986)			×	×	×	×
Duker (1994)			×	×		×
Goodman (1993)				×	×	
Linton (1984)				×		×
Remington (1993a)				×	×	
Remington (1993b)				×	×	
Sisson (1984)		×	×	×		
Wells (1981)			×	×		×
Wolery (1993)				×		×

<sup>a</sup>The table is modified from Schlosser *et al.* (2005) with permission from ISAAC. Full references may be requested from Ralf Schlosser (e-mail: rwschlosser@earthlink.net).

topic areas it may be appropriate to search only one database, provided this database is carefully selected.

*Determine relevant keywords*

CPG may also be useful for determining relevant individual keywords or combinations of keywords. The search was implemented with PsycINFO only based on the overwhelming evidence from the Pearl Growing example in support of this database over others related to this topic. Specifically, an author search was conducted to examine the keywords utilized to index these studies. The results are summarized in table 3. Interestingly, even though PsycINFO recognizes ‘augmentative communication’ as a keyword, none of the studies were indexed under this term. First, we thought that this had to do with the respective years associated with these entries — perhaps, these were dated prior to the 1994 adoption of augmentative communication as a keyword in PsycINFO. This, however, seemed unlikely because even entries as recent as 1996 were not indexed this way. This was especially surprising and revealing because the thesaurus defined augmentative communication to include aided and unaided approaches, and the latter includes manual signing. Thus, our PsycINFO ‘pearls’ suggest that one should not use the keyword ‘augmentative communication’ if the aim is to retrieve studies on manual signing.

A closer look at the keywords in table 3 indicates that the keyword ‘sign language’ is by far the most consistent keyword across these entries. In fact, it was used in 12 of the 15 entries. In the remaining few entries, the terms ‘manual communication’ or ‘communication skills training’ would be effective. This represents an example where the compilation of entries used for CPG allowed the searcher to establish a clear and consistent pattern. This would have been difficult to establish reliably with only one ‘pearl’ — as in TPG. In the AAC field,

**Table 3. PsycINFO indexing of manual sign treatment studies in terms of keywords and quality filters**

References	Keywords (subjects)	Free-text	Form/content type
Barrett (1987)	Communication skills training, moderate mental retardation, speech therapy	Compar*	Empirical study
Bennett (1986)	Manual communication, mental retardation, multiple disabilities, special education students, teaching methods	Compar*	Empirical study
Clarke (1986)	Severe mental retardation, <i>sign language</i> , vocabulary, language arts education, special education students	Alternating	Empirical study
Clarke (1988)	Communication skills training, phenylketonuria, severe mental retardation, <i>sign language</i> , verbal communication	Compar*	Empirical study
Conaghan <i>et al.</i> (1992)	Hearing disorders, mental retardation, positive reinforcement, practice, <i>sign language</i> , communication skills training, generalization (learning)	Compar*	Empirical study
Dalrymple (1992)	Moderate mental retardation, practice, reinforcement, severe mental retardation, <i>sign language</i> , nonverbal learning	Compar*	Empirical study
Ducker (1986)	Behaviour modification, Down's syndrome, institutionalized mentally retarded, reinforcement, <i>sign language</i>	Compar*	Empirical study
Duker <i>et al.</i> (1994)	Communication skills, profound mental retardation, severe mental retardation, stimulus control	Differential effectiveness; versus	Empirical study
Goodman (1993)	Reinforcement, severe mental retardation, <i>sign language</i> , special education students	Compar*	Empirical study
Linton (1994)	Mental retardation, overcorrection, positive reinforcement, practice, <i>sign language</i>	Alternating	Empirical study
Remington (1993a)	Comprehension, learning disabilities, severe mental retardation, <i>sign language</i> , special education students, communication skills training, selective attention	Compar*	Empirical study
Remington (1993b)	Communication skills training, comprehension, severe mental retardation, <i>sign language</i> , special education students, selective attention	Compar*	Empirical study
Sisson (1984)	Communication skills training, mild mental retardation, moderate mental retardation, oral communication, <i>sign language</i>	Compar*	Empirical study
Wells (1981)	Articulation (speech), communication skills training, severe mental retardation, <i>sign language</i> , speech therapy	Compar*	n.a.
Wolery (1993)	Delayed development, naming, preschool students, reading, teaching methods	Compar*	Empirical study

n.a., Not available. All of the above references are available on request from the author.

'sign language' is typically used for issues involved in deaf education whereas manual signs or manual signing is used for individuals using signs as an unaided form of AAC (Lloyd, Fuller, and Arvidson 1997). Therefore, the search revealed that the indexers of PsycINFO are not aware of this distinction in the use of this terminology. Had an AAC-knowledgeable individual entered 'manual signs' or 'manual signing' in the thesaurus there would have been no hits, and the searcher would have abandoned this search. CPG clearly helped detect the effective keyword 'sign language' for retrieving most of the evidence even though it may be counterintuitive to the terminology in the field. Because using this keyword alone would not have captured all of the 15 entries, this kind of search actually provides an avenue to detect several keywords that are plausible to string together with an OR strategy in order to get a higher yield (i.e. sign language OR manual communication OR communication skills training). Although a searcher may use the OR strategy without ever implementing a CPG strategy, this technique provides a more informed selection of keywords to string together because it is based on a larger sample of 'pearls.' Of course, the use of 'OR' will result in a larger number of hits because many entries indexed under communication skills training may not include manual sign issues and thus may not be relevant to the specific question. More entries will have to be examined for relevance and the searcher will have to decide whether the anticipated benefit is worth the additional cost.

#### *Determining relevant quality filters*

Researchers seeking to develop systematic reviews are interested in obtaining evidence that meets certain quality criteria. A CPG strategy may help identify appropriate quality filters for a specific database. Using the above example, the authors attempted to identify the quality filters used under the Form/Content Type category in PsycINFO. An analysis of table 3 reveals that the term 'Empirical study' was used in all but one case. While 'Empirical study' does encompass comparative designs it also includes empirical studies that are descriptive or intervention studies involving only one intervention. Any use of this filter would retrieve many other studies that are inappropriate. Given that this was the only available but less than satisfactory quality filter, the authors explored the use of free-text words. Free-text words allow the searching of any word used by the authors of the original studies in the title, abstract, text, or reference list. Specifically, we were looking for any kind of text words that would adequately signify comparative designs such as comparison, comparative, or alternating as in 'alternating treatments design.' This search revealed that by using Compar\*, it most consistently retrieved the kind of designs we were after. The asterisk is the truncation symbol in PsycINFO and permits the retrieval of words with the same root but different endings such as 'comparative', 'compared', and 'comparison'. CPG revealed a quality filter (i.e. Empirical study) that allows researchers to eliminate studies that are not data-based, and pointed out viable free-text quality filters to further narrow down the specific type of desired designs.

Because the narrative review from which this process started is very current and a multifaceted search strategy was used to arrive at this rather comprehensive list of relevant studies, the information gleaned from this CPG example will be useful to search effectively for evidence published in the future.

## Discussion

The techniques TPG and CPG were defined and illustrated. These techniques shall be discussed in terms of what they have to offer for practitioners interested in implementing EBP and researchers who wish to develop systematic reviews. While there are many parallels between these two techniques, there are also important differences (for a summary, see table 4).

Using TPG, starting with only one relevant article (the ‘pearl’), we were able to retrieve relevant studies with moderately little effort involving the sorting out of only few references that were false positives. In other words, there was a high degree of recall and precision. This is an important goal for any EBP search. This is why seasoned searchers use this strategy frequently to locate relevant, controlled vocabulary to add to their search query. For example, Drabenstott (2004) frequently begins with the Building Block Strategy (described earlier), which she suspends for a while, in order to do some TPG. In some situations, the controlled vocabulary needed for a search is very clear to the searcher so there is no need to use TPG. In situations, however, where there is some ambiguity due to a scattered literature across numerous databases, TPG is indeed very beneficial and deserves more attention in EBP as a viable search technique for practitioners who seek research evidence. Similarly, if the searcher is not knowledgeable about an area, TPG should be considered. Even when one presumes to have the right kind of controlled vocabulary, TPG can put this assumption to the test by comparing the controlled vocabulary anticipated by the searcher with actual indexing practices. This applies not only to keywords as discussed in various tutorials on Pearl Growing (e.g. Hawkins and Wagers 1982) but also to quality filters, which play an important role for retrieving only the best evidence. Because the use of thesaurus-based keywords and quality filters or limiters (i.e. controlled vocabulary) permits the retrieval of similar content regardless of the terminology used by the authors of original studies (Gallagher *et al.* 2002), these ‘corrected assumptions’ represent indeed very powerful information. Returning to our illustration, entries found subsequently to the ‘pearl’ revealed that MEDLINE appears to index studies that utilize single-subject experimental designs under the publication type ‘case reports.’ Per definition of the MeSH database, case reports are non-evaluative. Because single-subject

**Table 4. Comparison of traditional Pearl Growing with comprehensive Pearl Growing**

Features	Traditional Pearl Growing	Comprehensive Pearl Growing
Purpose	To aid a practitioner’s search for evidence to engage in EBP	To aid a researcher’s search for studies to be included in a systematic review
Information source needed	One or a few relevant article/s — the ‘pearl/s’ (a very small sample from the population of relevant studies)	Compilation of relevant articles — lots of ‘pearls’ (a large sample from the population of relevant studies)
Functions	<i>Suggests potentially</i> relevant: <ul style="list-style-type: none"> <li>• databases</li> <li>• keywords</li> <li>• quality filters</li> </ul> Suggests indexing problems	<i>Systematically identifies</i> relevant: <ul style="list-style-type: none"> <li>• databases</li> <li>• keywords</li> <li>• quality filters</li> </ul> Reveals indexing problems and informs their remediation
Representativeness	May not be representative	Highly representative
Effort	Fairly time efficient	Time consuming

experimental designs are evaluative and more stringent than case studies, however, this Pearl Growing illustration suggests a gross inaccuracy in MEDLINE's handling of such designs that warrant rectification. Therefore, searchers interested in retrieving studies with these kinds of designs should not rely on the publication type 'clinical trial' and presume that it is inclusive of single-subject experimental designs. In PsycINFO, the illustration documented that the quality filter suggested by the 'pearl' (i.e. 'empirical study') was accurate given the type of design used.

A caveat is, however, appropriate in considering this technique. Pearl Growing is based on the assumption that other relevant articles are indexed in the same or similar way as the 'pearl.' This assumption may prove accurate in many situations, but it cannot be ruled out that the 'pearl' itself may have been indexed in an atypical manner despite its high degree of content relevance. After all, the process of assigning controlled vocabulary is not without challenges. The probability of a practitioner encountering atypical indexing is very real given that this technique relies on only one 'pearl' or a few 'pearls' — a very small sample of the population of relevant entries. To minimize this probability, it is recommended to rely on at least several 'pearls' rather than just one. Given these potential limitations, TPG may not be sufficiently systematic in order to be used by researchers who aim to develop systematic reviews.

The CPG technique relies on a relatively large sample (close to the entire population) of relevant studies. As such, its primary purpose is to aid researchers in searching for studies to be included in systematic reviews. In doing so, it allows for a very informed assessment of actual indexing patterns, as demonstrated, in terms of databases, keywords, and quality filters.

CPG provides the searcher with data-informed guidance as to what databases provide the greatest yield for the question at hand in future searches. This cannot be accomplished to the same degree with TPG as it relies on only one or a few entries. Hood and Wilson (2001) conducted a study in which they determined that information scatter across bibliographic databases is topic-dependent and is more prevalent in interdisciplinary fields. Thus, it is of concern to the searcher to know how many databases need to be searched in order to yield a certain percentage of coverage. CPG is a strategy to aid the searcher with this decision.

In terms of keywords, the searcher can select the keyword or combination of keywords with the highest probability to work effectively based on existing data. In other words, it affords an evidence-based approach to searching. In our example, the searcher could decide to primarily rely on the keyword 'sign language' as this seemed to yield the most hits, and supplement it with other keywords added through the 'or' strategy in order to retrieve the few entries that are not indexed with sign language. Related to keywords, CPG can also suggest needed revisions to the existing indexing of articles. For example, it would be highly beneficial and appropriate to index the many studies involving manual signing with individuals with developmental disabilities also under the keyword 'augmentative communication' in PsycINFO because manual signs in AAC are viewed as part of unaided AAC approaches. The (through TPG) suggested shortcomings of MEDLINE in indexing single-subject experimental designs would benefit from follow-up analysis through the more stringent CPG technique.

In terms of selecting studies for purposes of CPG, there are benefits to choosing older references or more recent references, depending on the individual's search goal. Using more recent references provides the individual with information

concerning current indexing practices. This is likely to be more helpful if the goal is to retrieve current and (even) future evidence. Of course, one has to keep in mind that there will always be a time lag between the terminology used by authors of current publications and the keywords with which they are indexed. That is, the thesauri currently in use may be several years old, but nonetheless since they are being used to index new articles knowing these practices will help retrieve other new articles of similar content. Using older references, on the other hand, may allow the detecting of older indexing practices, which may yield the retrieval of similarly relevant articles published around the same time. Using older references permits one to discern changes in practices in the use of thesaurus-based keywords that may otherwise go unnoticed. For example, a researcher or practitioner may assume that by using 'alternative and augmentative communication' as a keyword in the CINAHL it should retrieve all relevant information concerned with the AAC field, inclusive of older research. This assumption is not correct, however, as this term was coined only in the late 1970s or early 1980s (Zangari *et al.* 1994). Any research that would today be considered AAC may have been indexed as 'non-speech communication' or 'non-oral communication'. Unfortunately, databases do not always re-index older references once terminology changes. Using CPG with older references may reveal this change in indexing practices, and facilitate the retrieval of evidence for researchers to develop systematic reviews because these aim to be comprehensive.

Finally, CPG bears some implications for the conduct and reporting of systematic reviews. Those who synthesize research evidence are advised to keep a log of how they found each study (Lipsey and Wilson 2000). However, rarely do these logs, if they were indeed gathered, enter a published review. If such logs were to include the database in which each study was found along with keywords and quality filters used to index each study, and was made available to the reader, the time-saving consequences for others become readily apparent. This could not only help practitioners in search of evidence but also future synthesists seeking to update a systematic review. Put another way, future syntheses might want to consider building CPG into their search protocol and reporting.

One of the limitations of CPG is that it is dependent on a large initial set of papers. For some topics, this might be difficult because a narrative review article may not be available. In these cases, TPG may be used generate this initial set when a review article is not available, and then use CPG to do the comprehensive search.

## Conclusions

TPG represents an important (previously ignored by the EBP searching literature) addition to the arsenal of search strategies for practitioners interested in EBP. This paper also extends the literature on TPG in that EBP had not been identified as an important search purpose. Up to this point, the literature on TPG had focused primarily on its benefits in suggesting appropriate keywords. This paper identified the suggestion of appropriate quality filters as a new benefit for TPG. CPG offers a new search strategy for researchers interested in searching for studies to be synthesized in systematic reviews. Previous works on searching for evidence to be included in systematic reviews do not mention this strategy (e.g. White 1994). CPG not only provides systematic and data-based guidance in selecting effective

databases, keywords, and quality filters, but also reveals indexing problems. However, due to the considerable amount of time required for CPG, it is not suitable for ad hoc EBP searches. This paper is not a tutorial, but a demonstration of how to use both variations of the strategy. More training is required to implement the strategy successfully, and future research should check what other kinds of knowledge is required to elaborate fully the strategy. Although these strategies were illustrated with examples from AAC, we suspect that it has applicability in other subfields of language and communication disorders as well as other healthcare fields. In the future, controlled studies would be beneficial to provide empirical support for the proposed effectiveness of TPG and CPG.

### Note

1. Schlosser *et al.* (2005) identified informational databases, reviewed search terminology, suggested practical strategies for successful searches in support of EBP, and exemplified these strategies with several search illustrations.

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